ELSEVIER

Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Engineering 29 (2012) 3858 – 3862

Procedia Engineering

www.elsevier.com/locate/procedia

2012 International Workshop on Information and Electronics Engineering (IWIEE)

Traffic Parameters Detection Using Edge and Texture

Yu Qiao[a]*, Zhongke Shi[a]

[a] *Northwestern Polytechnical University, 127 Youyi Xilu, Xi'an 710129, China*

Abstract

This paper proposes an approach towards the real-time detection of traffic parameters such as such as the stationary queue length and lane share in crossroad, based on the stationary camera installed along roadside. According to the characteristics of the traffic scene, Canny edge detection is used to get the edge information of region of interest (ROI). Local binary pattern (LBP) texture method is used to obtain the vehicle and road surface texture features and morphological processing is taken to enhance the responses of vehicle targets and reduce the noises generated by road lane and shadow interference. Then, edge and texture information is integrated to get the vehicle detection results, and inter-frame difference is taken to segment the moving and stationary vehicles. And then vehicle traffic parameters such as the stationary queue length and lane share are extracted. Through experiments taken in traffic command system of Dongguan City, the results show that this approach is accurate and performs well in real-time under different weather and illumination.

Keywords: edge detection; LBP texture; vehicle detection; traffic parameters extraction;

1. Introduction

In intelligent traffic control system, traffic parameters such as the length of vehicle queue and lane share are important parameter for traffic controller. Several kinds of sensors have been used to get these parameters. Comparing with other widely used detecting tools, like doughnut coil, radar, the detection of vehicles queuing based on video image processing can provide more visualized information, as well as accomplish sophisticated goals[1][2]. Many vision-based segmentation methods were proposed by

* Corresponding author. Tel.: +86 13474111479.
E-mail address: yqiaocn@163.com.

doi:10.1016/j.proeng.2012.01.584

researchers to detect and track vehicles, such as frame differencing[2], optical flow method, background subtraction[1][2][3], Gaussian mixture model (GMM)[4][5], Markov random field (MRF)[1][6]. The computation complexity of optical flow is not conducive to real-time processing, and the frame differencing can not detect stationary vehicles at intersection. And background subtraction is sensitive to change of the dynamic scene, and when the vehicle is stationary or traffic is serious congestion, some of vehicles may be updated as the background, leading to incorrect results. GMM also has the same problem. In this paper, we present another way to extract the vehicle queue length with the combination of edge and texture information. The second part introduces edge detection and the improvement of LBP texture information extraction. The third part illustrates the extraction algorithm of vehicle queue length and lane occupancy, while the practical application results of this algorithm are analyzed and discussed in the fourth part. After this, we finally draw a conclusion that this approach can satisfy the requirement of actual use.

2. Traffic Image Segmentation and ROI Correction

2.1. Image Segmentation

Traffic scene images contain lots of information about edge and texture which is the important feature to Segment different target.

After comparing the performance of Sobel gradient operator, Laplacian algorithm, LOG algorithm, Canny algorithm and wavelet transform modulus maxima algorithm under some typical traffic scenes, Canny algorithm is selected to extract the edge information of traffic video images in crossroad. Under the influence of weather, brightness and other factors, edge detection can still maintain a good result.

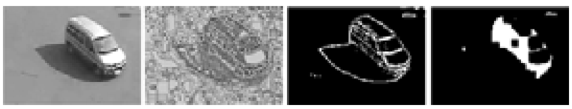
Image texture is the effective metric for the structure, direction and smoothness of the image. Local binary pattern (LBP) is originally developed in [7], using small local image features to signify the texture of image, and LBP is extended to a unified model and calculate in neighborhood based on different scales in [8], becoming a systematic theory. Definition:

$$LBP_{P,R} = \sum_{i=0}^{P-1} s(g_i - g_c)2^i \qquad Where \quad s(x) = \begin{cases} 1 & x \geq 0 \\ 0 & x < 0 \end{cases} \tag{1}$$

g_c is the gray value of the middle point, $g_i(i = 0,1,\cdots,P-1)$ is the pixel gray value of the pixel point which is around g_c with radius of R.

There are some particularities in the traffic intersection. Usually flat roads area contains only monotonous texture, while the vehicles traveling on the road contains abundant edge information and texture characteristics. So we can detect the texture information of RIO in traffic video image to distinguish roads and vehicles, and then extract the vehicle queue length. In this paper, we use the unit which P=8 and R=1 to describe the local image texture. Equation (1) is usually applied as threshold function. This approach is not suitable for the texture map description such as road, sky and other flat areas, and the anti-noise performance is poor. In this paper, the formulae (2) is involved as follow:

$$s(g_i - g_c) = \begin{cases} 1 & abs(g_i - g_c) \geq T \\ 0 & otherwise \end{cases} \tag{2}$$



(a) (b) (c) （d）

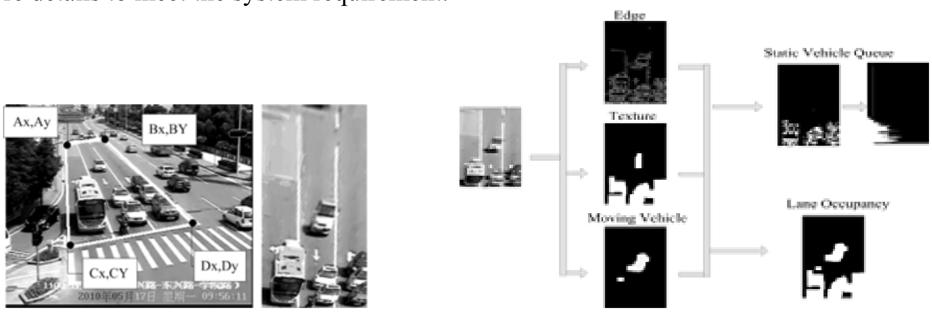
Fig. 1. (a) original image, (b) the result of reference [8], (c) result using formulae (2), (d) result after morphological operations

The example of texture maps results with different threshold functions is obtained as shown in Fig 1. In some lighting conditions, the shadow which comes from the scene beside the road and the vehicles of other lanes, directly impacts result of vehicle detection. But the LBP texture value is robust to the change of image local brightness. That means the road shaded area and non-shaded area has the similar texture value. This feature shown in texture map image is that there is a large texture value only in the boundaries of shadow area, and the texture values of the road area both under and out of the shadow are similar. The boundaries of shadow area in texture map can be eliminated by morphological operations. After open detecting the texture map, we can see that the feature of vehicle is reserved, and the noise of shadow is reduced. The results are shown in Fig.1(d).

2.2. Selection of Region of interest (ROI) and image correction

Actual conditions of crossroad sometimes are limited. Even Some intersections are not suitable for using image-based approach at all, because the lush trees or huge billboards nearly block the whole view of camera. In most conditions, cameras are fixed on traffic lights pole or a pole beside the road. Images taken by the camera of intersection not only include the road area, but also contain some information of environment which is not our concern. By setting a region of interest (ROI), we only process the pixel within the ROI to exclude the interference coming from the scene on both sides of the road and the vehicles of the other lane. The images captured by camera contain the phenomenon of perspective, and sometimes ROI is tilted in the camera field of view. Geometric correction is taken to process ROI in order to get the ideal image region. The results are shown in Fig.2(a).

After Geometric correction, all the ROI has same form that is convenient for processing with flexibility. Furthermore the image coordinates change into reality coordinates. So the information such as vehicle's size, queue length, and lane occupancy and so on can be more visually presented in the corrected image. In practical application, ROI can be divided, such as straight lane, left turn lane, in order to detect more details to meet the system requirement.



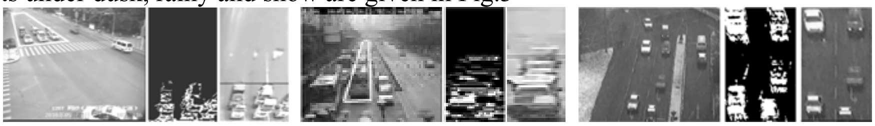
(a) (b)

Fig. 2. (a)example of image geometric correction, (b)Detection of vehicle queue length and lane occupancy

3. Detection of Traffic Parameters

When the traffic light is red or the road is in severe occlusion, vehicles are static or moving slowly under various dynamic environment conditions. The errors of vehicle detection result with frame differentiation and background subtraction are obvious. In this paper, we present a novel approach to detect the length of vehicle queue. Edge information about the ROI is obtained by Canny edge detection, and then LBP texture map is involved to eliminate the influence of the shadow, lane line and other factor. By combining the information of edge and texture, the influence factors such as shadow and water stain, are reduced; meanwhile the features of vehicle queue are enhanced. Frame subtraction with a frequency of 5 frames / sec is introduced to detect the moving objects. Then with the help of frame subtraction result, the moving vehicles are deducted from the fusion feature image which contains both edge and texture information shown in Fig.2(b). The position of vehicle queue tail is detected with the help of the image horizontal projection by selecting an appropriate threshold. According to the length of one vehicle which is an already known standard, the equivalent vehicle number of queue length can be obtained. And the lane occupation ratio of ROI can be calculated by ratio of the pixel number of vehicles which are both static and moving to the pixel number of the lane area.

In addition, our method can still maintain good stability and flexibility under different weather and illumination. such as dusk, rainy condition, the algorithm can still get a good result. The examples of detection results under dusk, rainy and snow are given in Fig.3



(a) (b) (c)

Fig. 3. (a) example of dusk, (b) example rainy, (c)example of snow

4. Results and Discussion

The following images in Fig.4 are the part of sequence image results processed towards the video data of Ligong Road in Dongwan city of Guangdong Province at a certain time period, and the black line in the images of second line shows the detected position of vehicle queue tail. The results of vehicle queue length and vehicle occupation ratio at this period is shown in Fig.5. The blue line stands for the actual number of vehicle in the line, and the red line means the number of vehicle in the queue calculated by this algorithm. We can find that the traffic lights about this crossing are of 2 phases. And the cycle of green lights is about 30 seconds and red one’s is about 90 seconds.

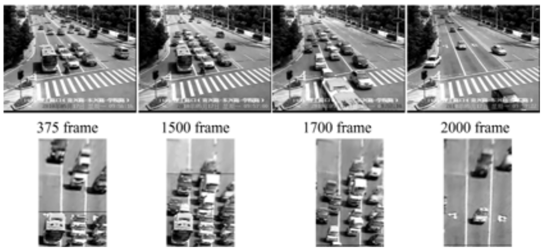
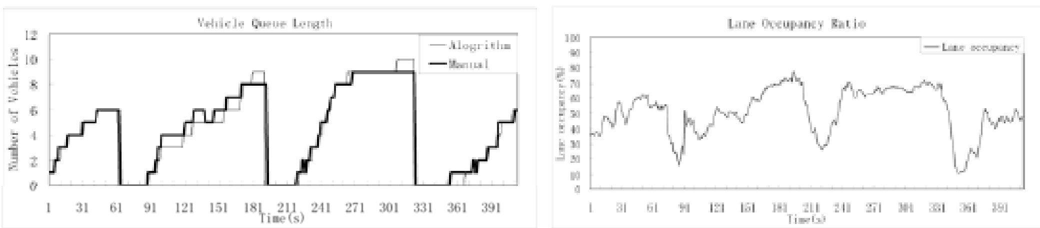


Fig. 4. sequence image results of Ligong Road in Dongguan city at a certain period.



(a) (b)

Fig. 5. (a) the equivalent vehicle number of queue length, (b) lane occupation ratio of Ligong Road at this period.

From Fig.5, we can see the length of Vehicle queue and lane occupancy reflecting traffic condition. In the red light cycle, length of vehicle queue and lane occupancy rise, while in the green light cycle, the length of static vehicle queue is 0. But there are lots of moving vehicles at this time, lane occupancy is still high, and with the passage of the time, it reaches to minimum at the end of the green light cycle. In general, length of vehicle queue is the main factor influencing red light cycle control. When length of vehicle queue achieves a certain length, the red light cycle should be terminated. On another hand, the lane occupancy is the main factor which influences green light cycle control. While most of vehicles pass the crossing, and lane occupancy falls to a certain level, the green light cycle should be ended.

The experiment is done by Visual studio6.0 in a computer with P4 2.66G and 521M, the process frequency can reach to five frame per second. So the algorithm fulfills the real-time application requirements relative to traffic lights cycle which is several seconds or longer. Experiments in various kinds of environments demonstrate that the result is robust and accurate, and the error is just about ±1 vehicle.

5. Conclusion

In this paper we have presented a traffic-monitoring approach for vehicle queue and lane occupancy detection based on image processing. For the video data gathered by fixed CCD camera on the intersection, after ROI selection and image correction, Canny edge and LBP texture are involved and combined to get vehicle feature without the influence of dynamic environment. With the help of moving objects detected by frame difference method, the length of static vehicle queue and lane occupancy are obtained, which are both important factor for traffic control. It has been successfully applied in traffic command system of Dongguan, Guangdong province, China. Experimental results prove that this approach provides the detected system with accuracy, flexibility and robustness.

Reference

[1] Norbert Buch, Sergio A.Velastin and James Orwell. A review of computer vision techniques for the analysis of urban traffic. IEEE Transactions on Intelligent Transportation Systems; 2011, 12(3), 920-939.

[2] Guolin Wang , Deyun Xiao and Jason Gu. Review on vehicle detection based on video for traffic. Proceedings of the IEEE International Conference on Automation and Logistics; Qingdao; 2008, 2961-2966.

[3] J. Zheng, Y. Wang, N. L. Nihan, and M. E. Hallenbeck. Extracting roadway background image: mode-based approach. Transportation Research Record: Journal of the Transportation Research Board; 2005, 1944, 82-88.

[4] B. Johansson, J. Wiklund, P. Forssén, and G. Granlund. Combining shadow detection and simulation for estimation of vehicle size and position. Pattern Recognition Letters; 2009, 30(8), 751-759.

[5] C. Stauffer and W. E. L. Grimson. Learning patterns of activity using real-time tracking. IEEE Transactions on Pattern Analysis and Machine Intelligence; 2000, 22(8), 747-757.

[6] P. Sturgess, K. Alahari, L. Ladicky, and P. H. S. Torr. Combining appearance and structure from motion features for road scene understanding. British Machine Vision Conference; London; 2009.

[7] T. Ojala, M. Pietikainen. Unsupervised texture segmentation using feature distributions. Pattern Recognition; 1996, 32, 477-486.

[8] T. Ojal, M. Pietikainen, T. Maenpaa. Multiresolution gray-scale and rotation invariant texture classification with local binary patterns. IEEE Transactions on Pattern Analysis and Machine Intelligence; 2002, 24(7), 971-987.